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Regional Case Study

Risk Factor Analysis of Dust Exposure with Symptoms of Respiratory Disorder in Brick Industry Workers in Tegowanuh Sub-District, Kaloran District, Temanggung Regency

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Abstract

The brick industry has the potential to create a source of pollution in the form of dust which is harmful to the environment and workers health from the burning process. This study aims to determine the risk factors and analyze the relationship between dust exposure and symptoms of respiratory disorder in workers. This study used the total sampling technique to choose a sample of 75 participants for an observational study with a cross-sectional approach. The results showed that the average total dust particulate levels at 13 points was 1748.47 µg/Nm3 and the average inhaled dust content in 75 respondents of 4.56 mg/m3. The results of the analysis showed that the variables associated with symptoms of respiratory disorder were inhaled dust levels (p=0.023), working period (p=0.040), length of exposure (p=0.032), and use of personal protective equipment (p=0.015). Workers in the brick sector in Tegowanuh Sub-District may have respiratory symptoms more frequently depending on their exposure to amounts of inhaled dust, working period, exposure duration, and use of personal protective equipment. During the work process, it is advised to use personal protective equipment as a mask to prevent the onset of respiratory problems.

Keywords: Dust exposure; symptoms of respiratory disorder; brick industry workers

1. Introduction

Health issues are a long-standing result of air pollution, particularly in industrialized nations where manufacturing work and motorized transportation predominate. A lack of pollution control brings on air pollution in the industry. One of the businesses that contribute to air pollution is the brick industry. The red brick business creates pollutants from dust and fumes from burning bricks. Workers are exposed to these contaminants in varying amounts and sizes due to their presence in the workplace (Lastri et al., 2019).

Workers may be exposed to dust because of the combustion process. Workers in the Tegowanuh Sub-District brick factory also apply sawdust to bricks that are being dried to increase burning. Burning bricks results in the release of pollutants from the fuel used, sawdust on the bricks, and enormous volumes of dust from the burnt rice husk ash (Siregar, Wahyuni et al., 2020).

The results of the measurement of the total dust at the time of the preliminary study were 1,747 µg/Nm^3 The threshold value for total dust, or TSP (Total Suspended Particulate), is 230 µg/Nm^3 based on

Government Regulation Number 22 of 2021 concerning Air Pollution Control, meaning that if no preventive measures are taken, this value will exceed the threshold value and may result in health issues like respiratory issues (Pemerintah Republik Indonesia, 2021).

A brick industry worker had their inhaled dust weight measured, and the results revealed that it was 14 mg/m^3. The Threshold Value for particulates not classified as inhalable is 10 mg/m^3, and the Threshold Value for particulates not classified as respirable is 3 mg/m^3, according to Regulation of the Minister of Manpower and Transmigration Number 13 of 2011 concerning Threshold Values for Physical Factors and Chemical Factors in the Work Area (Menteri Tenaga Kerja dan Transmigrasi, 2011). Workers exposed to this dust may have health issues, such as a reduction in forced expiratory volume in one second and a reduction in vital capacity volume (Ketenagakerjaan, 2018).

Industrial employees exposed to fuel-derived pollutants daily run the risk of developing occupational illnesses like bronchitis, emphysema, asthma, and other respiratory ailments resulting from lung inflammation (Siregar, Wahyuni et al., 2020). Workers who breathe in the dust are at a higher risk of respiratory ailments. This is characterized by a decline in lung function, which can lead to a reduction in the lung's ability to accommodate the amount of air, making it possible to link it to the prevalence of respiratory disorder (Ramadhansyah et al., 2020). Inhaling dust triggers a generalized defensive response that manifests as coughing and sneezing. Airway constriction may result from stimulating the smooth muscle around the airway. When the dust content surpasses the threshold value, this situation typically arises (Beard et al., 2022).

According to research done in 2020 by Wilda, there is a strong correlation between dust exposure during brickmaking and the prevalence of respiratory problems in brick sector workers ($p = 0.04$). A further investigation by Pramesti in 2021 revealed that 92% of the 42 workers had decreased lung function. The reduction in lung function capacity was significantly correlated with dust exposure ($p = 0.004$). Because there is a significant link ($p = 0.04$) and respiratory symptoms are a symptom of work-related illnesses, wearing personal protective equipment plays an essential role in triggering respiratory symptoms (Pramesti and Sutiari, 2021).

In preliminary research conducted in July 2022 in one of the brick production areas in sunny and somewhat windy conditions with a wind speed of 1.17 m/s and a temperature of 42.8 ^{o}C, the total dust measurement in one of the brick production areas was 1,747 µg/Nm^3. Eight out of ten (80%) workers had symptoms of respiratory disorder such as coughing, shortness of breath, and coughing up phlegm, according to the interviews performed as part of the researchers exploratory study activities with ten workers. Moreover, workers do not use personal protective equipment in the form of masks. These workers said that the activity that generates the most dust is when burning because they use firewood, corn cobs, husks, sawdust, or materials that could be used to burn bricks.

The researcher's consideration for choosing a research topic on respiratory symptoms was because the researcher wanted to find out whether exposure to dust produced in the brick making process was a risk factor for respiratory symptoms such as coughing, coughing up phlegm, and shortness of breath. This study's aim was to examine the relationship between dust exposure and symptoms of respiratory disorder in the brick industry in Tegowanuh Sub-District, Kaloran District, Temanggung Regency.

The originality of this study lies in the research variable, namely the total dust content and the inhaled dust content at the same location which is then associated with problems with respiratory symptoms. In addition, the subjects used were also different from previous studies where the brick industry used by other researchers was not located in Tegowanuh Village, Kaloran District, Temanggung Regency.

2. Methods

This quantitative study employs an analytical observational method and a cross-sectional design. Cross-sectional research measures the independent variable (total dust particulate levels, inhaled dust levels, working period, exposure duration, use of personal protective equipment, and smoking habits) and the dependent variable (symptoms of respiratory disorder). The acquired data is derived from measurements of total particle dust levels, inhaled dust levels, and interviews. Haz-Dust EPAM 5000 for total particulate dust level, Personal Dust Sampler for inhaled dust levels, and interview questionnaires were employed as data collecting equipment. This approach was selected because data were collected at a single time. The population of this research consisted of 75 brick industry employees from Tegowanuh Sub-District, Kaloran District, Temanggung Regency. This study utilized the complete sampling approach with the following inclusion criteria: willingness to be research subjects, work in the brick industry, and no history of respiratory illness.

This study analysis consists of two phases: univariate analysis and bivariate analysis. Data analysis in this study used the IBM SPSS Statistics 23 application, univariate analysis was undertaken to characterize the investigated distribution and frequency. The factors examined were total particle dust levels, inhaled dust levels, working period, exposure duration, usage of personal protective equipment, and smoking behaviours. In the bivariate analysis utilizing the Chi-Square test to examine the link between the independent variables and the symptoms of respiratory disorder, $p = 0.05$ was statistically significant (at the 95% confidence interval level). This study protocol has been deemed ethically sound and has gained information from the Health Research Ethics Commission of the Faculty of Public Health at Diponegoro University (certificate number 335/EA/KEPK-FKM/2022).

3. Result and Discussion

The research environment is inside the brick industry. Tegowanuh Sub-District, Kaloran District, Temanggung Regency is the location of the brick industry. This industry dates back to the 1980's. The brick-making industry comprises numerous processes, including earthwork, processing raw materials, printing, drying, burning, sorting, and selling. Bricks require a great deal of fuel, including wood, branches, leaves, husks, and old plastic. The work environment in the brick-making business in Tegowanuh Sub-District, Kaloran District, Temanggung Regency is typically dusty, as seen by the heavy smoke blowing, adhering, and scattering across the workplace. This fine dust can penetrate the human respiratory system, settling in the lungs and posing a health hazard to employees over time.

3.1 Respondent Characteristic

Table 1 data shows related characteristics of workers which include inhaled dust levels, working period, length of exposure, use of PPE, and smoking habits.

Table 1. Frequency Distribution of Respondent Characteristics

Variables	F (Person)	Percentage (%)
Inhaled Dust Levels		
≥3 mg/m³	55	73.3
<3 mg/m³	20	26.7
Working period		
≥10 years	56	74.7
<10 years	19	25.3
Exposure Duration		
≥7 hours/day	51	68.0
<7 hours/day	24	32.0
Use of Personal Protective Equipment		
Not Using	37	49.3
Using	38	50.7
Smoking Habits		

Variables	F (Person)	Percentage (%)
Smoking	37	49.3
Not Smoking	38	50.7

The results from table 1 show that the respondents who were exposed to dust above the Threshold Value (>3 mg/m^3) were 55 respondents with a percentage of 73.3%, while the respondents who were exposed to dust below the Threshold Value (<3 mg/m^3) were 20 respondents with a percentage of 26.7%. Based on Pramesti's research in 2021, exposure to dust inhaled by workers can cause respiratory problems. As many as 35 (97.22%) of respondents experience symptoms of respiratory disorder with inhaled dust levels that exceed the threshold value (>3 mg/m^3). In comparison, for workers who are in an environment with inhaled dust levels below the threshold value (>3 mg/m^3), there were 4 (66.7%) respondents who experienced symptoms of respiratory disorder. (Pramesti and Sutiari, 2021).

Regarding the working period, 56 (74.7%) of the respondents had worked in the brick industry for more than 10 years, and 19 (25.3%) of the other respondents had worked in the brick industry for less than 10 years. Working time in the brick industry is related to the accumulation of dust exposure received by workers. The longer the respondent worked, the more dust exposure they received (Kazi and Bote, 2019)

In the exposure duration variable, 51 (68.0%) respondents worked more than 7 hours per day, while 24 (32.0%) others worked less than 7 hours per day. The duration of exposure while working in the brick industry is a difficult time because the exposure length illustrates the respondent's exposure to pollutants. The longer the workers do their work, the greater the amount of exposure received (Ridayanti et al., 2022)

In the use of personal protective equipment (PPE) variable, 37 (49.3%) of the respondents did not work using personal protective equipment in the form of masks. In comparison, 38 (50.7%) of other respondents worked using personal protective equipment in the form of masks. However, they did not meet the standards because the respondents used cloth masks, unused clothes, or buff masks so that pollutants in the work environment could enter the respiratory tract. The use of cloth masks is ineffective because dust and smoke from combustion can enter the respiratory system. (Pramesti and Sutiari, 2021).

In the smoking habit variable, 37 (49.3%) respondents had a smoking habit, while 38 (50.7%) other respondents did not have a smoking habit. According to the theory of clinical symptoms caused by changes in the lungs, such as changing the anatomy of the respiratory tract due to smoking habits. (Pratali et al., 2019).

3.2. Symptoms of Respiratory Disorders in Brick Industrial Workers

In this study, measurement of the variable of symptoms of respiratory in brick industry workers in Tegowanuh Sub-District, Kaloran District, Temanggung Regency was grouped into 2, namely experiencing symptoms of respiratory disorder (symptomatic) and not experiencing symptoms of respiratory disorder (asymptomatic). Data on measuring respiratory symptoms in 75 workers at thirteen points in the red brick manufacturing industry showed that 37 respondents experienced symptoms of respiratory 49.3%, and 38 respondents did not experience symptoms of respiratory with a percentage of 50.7%. Based on the interview results, workers respiratory problems include shortness of breath, dry cough, and cough with phlegm.

The work environment with high air pollution conditions greatly influences the incidence of symptoms of respiratory based on the results obtained by other researchers. Symptoms of respiratory disorder are diseases of the upper or lower respiratory tract that can cause various symptoms in exposed workers, such as shortness of breath and coughing acutely or chronically (Siregar, Wahyuni et al., 2020). Symptoms of respiratory disorder are one of the problems for workers, especially workers who do work with high levels of dust exposure. Increased resistance to the airways during the expiration process is a problem that arises when workers experience symptoms of respiratory disorder caused by the narrowing of the airways (Ramadhansyah et al., 2020).

Dust characteristics, which include particle size, shape, concentration, adhesiveness, chemical properties, and exposure duration, influence respiratory disorders appearance. Individual factors include respiratory tract physiology, anatomy, pulmonary defence mechanisms, and immunological factors. Another factor that causes respiratory problems is the work profession carried out by a person (Rupakheti et al., 2018).

Many factors influence the occurrence of respiratory symptoms experienced by workers in work environments where dust levels are above the threshold value. One of the modifiable factors for respiratory symptoms is smoking habits and adherence to personal protective equipment. Meanwhile, other factors of symptoms of respiratory disorders that cannot be changed include age and history of respiratory tract disease. The occurrence of symptoms of respiratory disorders can be prevented if self-control is carried out. Things that must be done to reduce the level of risk of developing respiratory symptoms are the need to adopt a healthy lifestyle, such as reducing the intensity or stopping smoking in daily life (Nazira et al., 2022).

Table 2. Frequency Distribution of Symptoms of Respiratory Disorder

Symptoms of Respiratory Disorders	F (Person)	Percentage (%)
Symptomatic	37	49.3
Asymptomatic	38	50.7
Total	75	100

3.3. Analysis of Risk Factors of Dust Exposure with Symptoms of Respiratory Disorder

Total dust particulate levels, inhaled dust levels, working period, exposure duration, compliance with the use of personal protective equipment (PPE), and smoking habits are the independent variables that will be tested with the dependent variable, namely symptoms of respiratory disorder. Chi-square was used in the analysis with a p value <0.05 which indicates a statistically significant relationship. The value of RP (Prevalence Ratio) of more than 1 is interpreted as the variable studied is a risk factor associated with symptoms of respiratory disorders.

Table 3. Relationship between Risk Factors with Symptoms of Respiratory Disorder

No	Variabel	Symptoms of Respiratory Disorder		*p-value*	PR	95 % CI	
		n= 75				Lower	Upper
1	**Total Dust Particulate Levels**			0.298	1.514	0.762	3.010
	≥ 230 µg/Nm³	31 (53.4%)	27(46.6%)				
	≤ 230 µg/Nm³	6 (35.3%)	11 (64.7%)				
2	**Inhaled Dust Levels**			0.023*	2.373	1.055	5.135
	≥ 3mg/m³)	32 (58.2%)	23 (41.8%)				
	< 3mg/m³)	5 (25.0%)	15 (75.0%)				
3	**Working period**			0.040*	2.171	0.990	4.765
	≥ 10 Years	32 (57.1%)	24(42.9%)				
	< 10 Years	5 (26.3%)	14 (73.7%)				
4	**Exposure Duration**			0.032*	2.017	1.038	3.919
	≥ 7 hours/day	30 (58.8%)	21 (41.2%)				
	< 7 hours/day	7 (29.2%)	17 (70.8%)				
5	**Use of Personal Protective Equipment**			0.015*	1.896	1.149	3.128
	Not Complete	24 (64.9%)	13 (35.1%)				
	Complete	13 (34.2%)	25 (65.8%)				
	Smoking Habits			0.299	1.348	0.845	2.150
6	Yes	21 (56.8%)	16 (43.2%)				
	No	16 (42.1%)	37 (57.9%)				

* : Significant

3.4. Relationship between Total Dust Particulate Level with Symptoms of Respiratory Disorder

According to the results of table 3, 31 (53.4%) of the 58 respondents were exposed to levels of total dust particulates above the quality standard (> 230 µg/Nm³), while the other 27 respondents (46.6%) were asymptomatic. Meanwhile, 6 (35.3%) of the 17 respondents who were exposed to total dust below the quality standard (< 230 µg/Nm³) experienced symptoms of respiratory disorder, and 11 (64.7%) of the other respondents were asymptomatic. Statistical test results showed that there was no significant relationship between total dust particulate levels and the symptoms of respiratory disorder in brick industry workers in Tegowanuh Sub-District, Kaloran District, Temanggung Regency (p = 0.298; RP = 1.514; 95% CI = 0.762 – 3.010) (p-value > 0.05) which indicates that the total dust particulate content is not a risk factor for the occurrence of symptoms of respiratory disorder. However, more total dust particulates can endanger the workers themselves. The more workers are exposed to dust particulates, and the dust will accumulate over time (Pramesti and Sutiari, 2021) .

According to the Republic of Indonesia Government Regulation Number 22 of 2021 on ambient air quality standards, the quality standard value for total dust particulate levels is 230 µg/Nm³, indicating that total dust particulate levels that exceed the quality standard value increase the risk of experiencing symptoms of respiratory disorder. In theory, the higher the total dust particulate content in an industrial environment, the greater the risk of experiencing symptoms of respiratory disorder in workers who work in that area, compared to working in an environment where the total dust particulate content is less than the threshold value (<230 µg/Nm³) (Pemerintah Republik Indonesia, 2021).

This finding contradicts Fatimah's 2018 research, which found a link between total dust particle levels and decreased respiratory function (p = 0.020; RP = 2.280; 95% CI = 1.078 - 4.821) with a total dust particulate level of 290 µg/Nm³ that above the threshold value (230 µg/Nm3). Due to differences in the workers' health, a person exposed to the same quantity of dust might induce distinct clinical abnormalities (Fatimah et al., 2018).

Furthermore, it is supported by the findings of Permatasari's 2018 study, which found that total dust particle levels were a risk factor for the incidence of symptoms of respiratory disorder. Field interviews revealed that, while overall dust particle levels surpassed the threshold value, the dose of exposure that entered the worker's body varied depending on the time of exposure and the usage of personal protective equipment (Gupta et al., 2019a). The findings of this study are also consistent with Mirza's research from 2021, which found an association between total dust exposure and respiratory illnesses (p value = 0.048) (Fuadi et al., 2021).

Workers who are exposed to total particulate dust above the threshold value (≥ 230 µg/Nm³) are expected to be able to modify their working hours, the distance between their resting places and burning stoves, and their use of personal protective equipment to lessen the likelihood that they will experience symptoms of both chronic and acute respiratory disorders. This is since if employees inhale substantial amounts of dust, dust levels that are beyond the threshold value may have an impact on their respiratory tract diseases. Industrial employees can take preventive measures like wearing masks as personal protective equipment to lessen their exposure to contaminants and lower their risk of developing respiratory problems (Siregar, Wahyuni et al., 2020).

3.5. Relationship between Inhaled Dust Exposures with Symptoms of Respiratory Disorder

Based on the results of table 3, 55 respondents who were exposed to dust above the threshold value (>3 mg/m³) there were 32 (58.2%) respondents who experienced symptoms of respiratory disorder, while 23 (41.8%) other respondents did not experience symptoms respiratory disorders. Of the 20 respondents who were exposed to dust below the threshold value (< 3 mg/m³), 5 (25.0%) experienced symptoms of respiratory problems, while 15 (75.0%) of other respondents did not experience symptoms of respiratory disorder. Statistical test results prove that there is a significant relationship between inhalation of dust exposure and the incidence of symptoms of respiratory disorder in brick industry

workers in Tegowanuh Sub-District, Kaloran District, Temanggung Regency (p = 0.023; RP = 2.373; 95% CI = 1.055 – 5.135), RP value = 2.373 has This means that industrial workers who are exposed to inhaled dust above the threshold value (> 3mg/m³) have a risk of experiencing symptoms of respiratory disorder 2.373 times greater than brick industry workers who are exposed to inhaled dust below the threshold value (> 3mg/m3). It is known that the RP value is 2.373 (RP> 1) with a 95% Confidence Interval (CI) = 1.055 – 5.135, which means that exposure to inhaled dust is a risk factor for the occurrence of symptoms of respiratory disorder.

This finding is consistent with the study done by Pramesti in 2021, which discovered that 35 (97.22%) respondents had symptoms of respiratory disorder when exposed to environments with high levels of dust and breathed dust levels that surpassed the threshold value (>3 mg/m³). When lived below the threshold amount (>3 mg/m³), 4 responders (66.7%) reported having respiratory tract issues. Statistical analysis revealed a strong correlation between total dust content and employees' respiratory complaints (p = 0.007) (Pramesti and Sutiari, 2021).

The results of measurements carried out by Sanjel in 2018 in the Kathmandu valley, Nepal found an average inhaled dust level of 400 brick industry workers of 5,888 mg/m³ with complaints such as chronic cough, chronic cough with phlegm, bronchitis, shortness of breath, and asthma with a value p-value below 0.05 (Sanjel et al., 2018).

The elevated exposure to inhaled dust is assumed to be caused by high levels of total dust particles in Tegowanuh Sub-District, Kaloran District, Temanggung Regency's brick industrial sector. The level of breathed dust was measured at thirteen different sites, such that the exposure to inhaled dust varied depending on the point and the furnace. The combustion process creates the most dust because it consumes fuels such as wood, husks, twigs, leaves, and plastic, which produces a considerable quantity of smoke and dust, and dust particles are spread in industrial regions (Siregar, Wahyuni et al., 2020).

In the combustion process, the distance between the furnace and workers tends to be close, plus workers who do not use personal protective equipment (PPE) in the form of masks. Workers who do not wear masks have a significant risk of dust exposure because they cannot filter dust effectively because they are made of cloth, unused clothing, or masks that can be cleaned. Workers are at risk of developing respiratory tract diseases due to buildup in the lungs caused by dust that is inhaled and enters the respiratory system. Therefore, there is a need for education about the use of masks that meet the criteria when working, especially in places where there is a danger of exposure to dust, from the head of Tegowanuh Sub-District and health workers such as Puskesmas, Hospitals, and the Health Office (Pramesti and Sutiari, 2021)

3.6. Relationship between Working Period with Symptoms of Respiratory Disorder

Based on the results in table 3, of the 56 respondents whose working period was > 10 years, 32 (57.1%) of the respondents experienced symptoms of respiratory disorder, while 24 (42.9%) of the other respondents did not experience symptoms of respiratory disorder. Of the 19 respondents whose working period was <10 years, 5 (26.3%) experienced symptoms of respiratory disorder and 14 (73.3%) other respondents did not experience symptoms of respiratory disorder. Statistical test results prove a significant relationship between the length of service and the incidence of symptoms of respiratory disorder in brick industry workers in Tegowanuh Sub-District, Kaloran District, Temanggung Regency (p-value = 0.040; RP = 2.171; 95% CI = 0.990 – 4.765). The value of RP = 2.171 (RP > 1) means that brick industry workers whose working period is > 10 years have a 2.171 times greater risk of experiencing symptoms of respiratory disorder compared to workers who have worked < 10 years.

This study's findings support the theory that the longer a person stays in the same work, the greater their chance of developing occupational disorders. Theoretically, dust exposure can affect humans depending on the dose, concentration, location, and duration of exposure. As a result, the more prolonged people labour in dusty surroundings, the greater dust exposure they experience. Exposure time is defined as the frequency or duration of a person's exposure to dust; the longer a worker is exposed to dust, the

greater the likelihood of respiratory difficulties, particularly at high exposure concentrations (Abrihari et al., 2022).

This study's findings are consistent with a 2019 study by Rufiat that shown a correlation between tenure and respiratory complaints (p = 0.002) (Kazi and Bote, 2019). In addition, this study is consistent with research conducted by Apsari in 2018 which demonstrated that working periods can cause respiratory problems because if an individual works in an environment with a high level of air pollution and is not equipped with personal protective equipment, the risk of developing respiratory problems increases (Apsari L et al., 2018).

The research results are in line with the research conducted by Singh in 2020 which states that workers who have worked for more than 10 years have a risk of experiencing respiratory disorder (p = <0.001) (Singh et al., 2020). The research conducted by Rezazahehazari in 2020 in Tehran Province (Gharchack and Varamin) it was found that working period did not directly affect respiratory problems because pollutants that entered the respiratory tract did not react directly but required a long time, so if someone does work in a risky place with time for a long time will cause health problems(Rezazadehazari et al., 2020).

When a worker has been worked for more than ten years, more dust is ingested by the body. Age can affect the respiratory system; as humans age, the respiratory muscles degenerate, the suppleness of the respiratory tissue reduces, and the strength of the respiratory muscles when inhaling oxygen diminishes. Then, as a result of ageing, more alveoli in the body become damaged, and the body's resistance (Subhanullah et al., 2022). Consequently, a person's susceptibility to respiratory disease symptoms increases with age, and exposure to dust that might accumulate in the lungs can also provoke respiratory disorder symptoms in older individuals. This is because the longer brick industry workers are exposed to irritating dust, particularly in the combustion sector, the higher their risk of developing respiratory difficulties (Singh et al., 2020)

To minimize the threat of dust exposure, industrial combustion workers with more than ten years of experience should have sufficient rest and flexible working hours, so they do not remain in the industrial environment for too long after their task is over. To lessen the chance of symptoms of respiratory disorder developing in industrial workers, coworkers can arrange work schedules so that each worker performs their duties at the same time. Theoretically, other ways to lower the chance of acquiring symptoms of respiratory disorder in workers with a 10-year work history include completing frequent health checks, utilizing personal protective equipment, and implementing good lifestyle habits such as exercising and getting enough rest (Reza et al., 2022).

Furthermore, personal protective equipment such as masks will protect them from exposure to contaminants such as dust so that the dust is not inhaled into the respiratory tract and buried in it so that it does not cause blockage of the respiratory tract and cause respiratory problems. Then people who do a healthy lifestyle such as exercise can minimize the symptoms of respiratory disorders because exercise can cause the respiratory muscles to become more elastic and stronger (Chendra S and Lontoh SO, 2019).

According to the theory, doing these things can reduce the risk of developing symptoms of respiratory disorder early on. Based on the results of previous studies, people who check their health regularly can find out whether or not there are problems with their bodies caused by working in risky places for long periods (Benny Yulianto et al., 2021).

3.7. Relationship between Exposure Duration with Symptoms of Respiratory Disorder

Based on the results in table 3, out of 51 respondents who had worked > 7 hours/day, there were 30 (58.8%) respondents experienced symptoms of respiratory disorder and 21 (41.2%) other respondents did not experience symptoms of respiratory disorder. Meanwhile, of the 24 respondents who did their work <7 hours/day, there were 7 (29.2%) respondents experienced symptoms of respiratory disorder and 17 (70.8%) other respondents did not experience symptoms of respiratory disorder. Statistical test results

proved a relationship between the length of exposure and the incidence of symptoms of respiratory disorder in brick industry workers in Tegowanuh Sub-District, Kaloran District, Temanggung Regency (p-value = 0.032; PR = 2.017; 95% CI = 1.038 – 3.919). The value of RP = 2.017 (RP > 1) means that workers in the red brick industry who have working hours of more than 7 hours/day have a 2.017 times greater risk of experiencing symptoms of respiratory disorder compared to workers who work less than 7 hours per day.

The results of this study are in line with research conducted by Wilda in 2020, which showed that the length of exposure had a relationship with the incidence of symptoms of respiratory disorder in brick-making workers (p = 0.004) (Siregar, Wahyuni et al., 2020). Apsari conducted other supporting research results in 2018, which found that the length of exposure had an essential role in the incidence of symptoms of respiratory disorder in workers (Apsari L et al., 2018).

According to the hypothesis, the risk of respiratory problems increases with prolonged exposure (7 hours per day). This is to ensure that workers, particularly those who perform hazardous tasks and are exposed to dust for an extended duration of time, are more likely to be exposed for a more extended period than those who work fewer than 7 hours per day. When performing dangerous tasks or working in an environment with much dust, workers are typically at a higher risk of exposure (Presiden Republik Indonesia, 2003; Siregar, Wahyuni et al., 2020)

The length of exposure is the time a person spends in the work environment. Brick industry workers spend a minimum of 3 hours and a maximum of 18 hours a day, depending on the type of work being done. If the working time is extended, it will cause high inefficiency and can even trigger disease caused by the duration of exposure received by workers in the industry (Siregar, Wahyuni et al., 2020)

The working period is limited to 7 hours per day or 40 hours per week, per Law of the Republic of Indonesia No. 13 of 2013 Concerning Manpower (Presiden Republik Indonesia, 2003). The longer a worker works, the longer he is exposed to dust as a result, the likelihood of developing pulmonary function disorders increases. However, this risk also depends on the concentration of dust present, each person's mechanism for clearing the dust, the dust's chemical makeup, the dust particles' size and content, and their susceptibility (Abrihari et al., 2022; Ridayanti et al., 2022)

Witten's research from 2019 revealed that people who work seven hours a day encounter respiratory issues because they do not wear personal protective equipment and smoke at work, which causes the body to accumulate chemicals and dust that cannot be eliminated from the respiratory organs (Witten et al., 2019).

Alternative problem solving to reduce the level of risk of the occurrence of symptoms of respiratory disorder for workers who work more than 7 hours or <7 hours based on theory is to take preventive measures such as personal protective equipment in the form of masks to reduce the exposure received by workers, and the amount of dust inhaled can minimize so that the possibility of the symptoms of respiratory disorder can be minimized (Ipmawati PA, 2018).

Additionally, routine health examinations can be done to check for lung disease in industrial employees so that individuals with the condition and at risk of developing symptoms of respiratory disorder can receive appropriate treatment (ILO, 2013). According to a study by Apsari in 2018, a different option that can be implemented is the necessity to enhance the work shift system to offer adequate rest time and decrease indications of disease symptoms brought on by exposure in the workplace (Apsari L et al., 2018) .

Prevention measures are taken such as using masks as minimal personal protective equipment to reduce exposure received by workers and the amount of dust inhaled, to reduce the risk of the occurrence of symptoms of respiratory disorder for workers who work for more than or less than seven hours per day to reduce the chance of contracting acute respiratory infections (Lastri et al., 2019).

3.8. Relationship between the Uses of Personal Protective Equipment with Symptoms of Respiratory Disorder

Based on the results in table 3, 24 (64.9%) of the 37 respondents who did not fully comply with the use of personal protective equipment (PPE) experienced symptoms of respiratory disorder and 13 (35.1%) other respondents did not. Of the 38 respondents who used PPE in the form of masks, 13 (34.2%) respondents experienced symptoms of respiratory disorder and 25 (65.8%) other respondents did not. There is a significant relationship between the variable compliance with the use of PPE and the incidence of symptoms of respiratory disorder in brick industry workers in Tegowanuh Sub-District, Kaloran District, Temanggung Regency, with statistical results (p-value = 0.015; RP 1.896; 95% CI = 1.149 – 3.128). The value of RP = 1.896 (RP > 1) means that workers in the red brick industry who do not use personal protective equipment in the form of masks have a 1.896 times greater risk of experiencing symptoms of respiratory disorder than workers who use masks during their work..

By increasing the number of exposure that enters the body, workers who do not wear PPE in the form of masks risk developing both acute and long-term health issues. As a result of interviews and field observations, it was discovered that out of 75 respondents, 36 did not wear masks while working because doing so made them feel uncomfortable and hot. The other 39 respondents also wore masks made of cloth, old clothes, or washable cloth. As a result, it is conceivable for employees who wear personal safety equipment (PPE) like masks to be exposed to dust and smoke from burning as a result of their PPE. Dust is poorly filtered by use. This is consistent with the premise that using protective equipment is crucial when working to reduce the likelihood of exposure entering the body, one of which does so through breathing and skin (Pramesti and Sutiari, 2021).

The findings of this survey are consistent with those of Pramesti's research from 2021, which discovered that 78.57% of workers had a harmful habit of utilizing PPE and did so mostly when their superiors were in charge of the workplace. According to the chi-square test analysis's findings (p = 0.004), there is a substantial correlation between using PPE and respiratory diseases (Pramesti and Sutiari, 2021). This research is in line with the research of Derso in Ethiopia in 2021 which says that there is a significant relationship between the use of personal protective equipment and respiratory problems, with workers who do not use personal protective equipment at risk of experiencing respiratory problems 9.1 times compared to workers who use personal protective equipment (Derso et al., 2021)

Workers in the brick industry are particularly vulnerable to dust exposure from mouth and nose inhalation. To reduce the exposure the worker receives, personal protection equipment (PPE) must be worn. Using personal protection equipment (PPE) like a mask to protect the respiratory tract, which serves as a pathway for outside exposure, is one technique to stop the body from absorbing dust. To prevent direct contact with dust during the brick-making process, brick industry workers should be allowed to utilize PPE in the form of masks and extras such as long sleeves, pants, gloves, glasses, hats, and shoes. Additionally, coworkers might urge one another to use personal protective equipment, particularly masks, when constructing bricks (Pramesti and Sutiari, 2021).

The inability of personnel to use PPE, such as masks, while performing their jobs can result in symptoms of respiratory disorder (Gupta et al., 2019b). Alternative solutions to issues were revealed by research done by Ipmawati in 2018 including recommendations for personal protective equipment that can be pursued as an early protection measure against accidents and occupational diseases that arise in the workplace environment, then implementing fundamental policies regarding the application of occupational safety and health at work to minimize the number of occupational diseases, especially dust (Ipmawati PA, 2018).

In the meantime, the Minister of Health's Regulation No. 48 of 2016 on OSH Standards stipulates that one of the occupational health standards is improving occupational health by increasing knowledge of occupational health, so it is hoped that health workers from health centres or other health workers can provide information and education about the use of masks. The correct and effective manner of operating in dusty environments, as well as the possible health effects (Menteri Kesehatan Republik Indonesia,

2016). Depending on the sort of activity the worker performs, such as kneading materials, printing, or burning, specific potential risks are present in each task. The higher the number of dust pollutants absorbed and the greater the likelihood that the respondent would develop respiratory distress symptoms without personal protective equipment, the closer they are to the burning location (Subhanullah et al., 2022).

3.9. Relationship between Smoking Habits with Symptoms of Respiratory Disorder

Based on the results in table 3, of the 37 respondents who had smoking habits, 21 (56.8%) respondents experienced symptoms of respiratory disorder and 16 (43.2%) other respondents did not. Of the 38 respondents who did not have smoking habits, 16 (42.1%) respondents experienced symptoms of respiratory disorder and 22 (57.9%) other respondents experienced no symptoms. Statistical test results obtained (p-value = 0.299, RP = 1.348, 95% CI = 0.845 – 2.150) (p-value> 0.05), which means that there is no relationship between smoking habits and the incidence of symptoms of respiratory disorder in brick industry workers in Tegowanuh Sub-District, Kaloran District, Temanggung Regency. RP = 1.191 with a 95% Confidence Interval (CI) = 0.854 – 1.661, indicating that smoking is not a risk factor for symptoms of respiratory disorder. These results indicate that brick industry workers in Tegowanuh Sub-District, Kaloran District, Temanggung Regency, have no risk of developing symptoms of respiratory disorder if the worker has a smoking habit or does not have a smoking habit.

These findings are consistent with Apsari's 2018 study, which found that smoking does not affect the prevalence of respiratory illnesses but may, in principle, affect lung conditions, which, if worse by continued smoking, may cause health issues (Apsari L et al., 2018).

Smoking habitual respondents are more likely to get respiratory difficulties. The research findings show that there is no connection between smoking behaviours and the incidence of symptoms of respiratory disorder, even though smoking is theoretically a risk factor for the development of symptoms of respiratory disorder. Theoretically, compared to non-smokers, the habit increases a person's chance of blockage by a factor of four. One of the primary causes of respiratory illness is smoking (Pratali et al., 2019).

According to studies done by Pratali in 2019, continuing the habit of smoking can shrink the airways and cause severe harm to organs like the lungs if it is not halted. This is because smoking's toxic accumulation will settle over time (Pratali et al., 2019). According to Nabilla's research from 2018, smokers are more likely to experience the signs and symptoms of respiratory illnesses because smoking alters how the human respiratory tract functions, increasing the risk of damage to the alveoli and inflaming the cells in the lung tissue. These modifications cause clinical abnormalities, which trigger a continuous obstruction (Nabilla et al., 2018).

Smoking reduces essential lung capacity more than certain workplace dangers. Lung defences are harmed by cigarette smoke. The cilia's movement will slow down and weaken as time goes on. The mucus glands and mucosal cells of the sizeable respiratory tract may get more extensive in smokers (Siregar, Wahyuni et al., 2020). Smoke from cigarettes and dust from the workplace can constrict the channel, leading to a buildup of mucus in the small respiratory tract (Brinkman GL and Coates EO Jr, 1963). Although the smoking habit variable in this study did not have a relationship with the incidence of symptoms of respiratory disorder, several steps could be taken to reduce the risk of developing symptoms of respiratory disorder as a result of smoking, including cutting down or quitting smoking, getting regular health checks, and maintaining a healthy lifestyle that includes getting enough exercise and rest (Siregar, Wahyuni et al., 2020). Regular health checkups can reduce respiratory symptoms due to instructions from health professionals and help stop smoking behaviours if the examination results show a respiratory tract disease (Putra, 2014). According to a study by Putra in 2014, other ways to lessen the risks of smoking include throwing away or hiding cigarette packs or lighters, compiling a list of the benefits and drawbacks of smoking, and avoiding social situations where smoking is present (Gupta et al., 2019a; Pramesti and Sutiari, 2021).

4. Research Limitations

Other researchers can continue further research regarding the relationship of factors other than the influence of dust exposure such as ages, economic status, health services, history of respiratory disease, body mass index, exercise habits, and worker hygiene, this is due to limited research time by researchers.

5. Conclusions

Several variables were found which are risk factors in this study that have a relationship with of respiratory disorder in brick industry workers in Tegowanuh Sub-District, Kaloran District, Temanggung Regency, including exposure to inhaled dust, working period, length of exposure, and the use of personal protective equipment such as masks. While the variables that do not have a relationship with symptoms of respiratory disorders in workers are total dust particulates and smoking habits. The biggest risk factor for dust exposure to the incidence of symptoms of respiratory disorder is that inhaled dust exposure above Threshold Value (>3 mg/m^3) has a 2,373 times greater risk of experiencing symptoms of respiratory disorder. Brick industry workers who are exposed to total dust or inhaled above the threshold value are expected to use personal protective equipment in the form of masks to avoid direct exposure to dust during the brick making process.

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